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Identifying Barriers to Effective Subject Access in Library Catalogs

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Fifty-one subject searches were performed in on online catalog, containing about 4.5 million records. Their success was judged in terms of lists of items, known to be relevant to the various topics, compiled by subject specialists (faculty members or authors of articles in specialized encyclopedias). Many of the items known to be relevant were not retrieved, even in very broad searches that sometimes retrieved several hundred records, and very little could be done to make them retrievable within the constraints of present cataloging practice. Librarians should recognize that library catalogs, as now implemented, offer only the most primitive of subject access and should seek to develop different types of subject access tools.

The replacement of the card catalog by the online catalog brought with it a great resurgence of interest in the problems of subject access in general. This is hardly surprising in view of the fact that the online catalog promised to offer subject search capabilities that were substantially better than those offered by its predecessor.

Many studies on how to improve subject searching in online catalogs have already been performed. The approaches most frequently Investigated can be grouped into five broad categories:

1. Those that rely on improved or more flexible approaches to the searching of elements (e.g., subject headings) already commonly searched,
2. Those that extend search capabilities to more elements in existing bibliographic records,
3. Those that would enhance existing bibliographic records by adding further searchable elements,
4. Those that would make further searching aids available to the library user.
5. Those concerned with usefully limiting the number of records retrieved in simple search approaches (e.g., single keyword in title) that would otherwise cause an unacceptably large retrieval from a database of any significant size.

Examples of the first group include studies involving improved word-stemming, techniques for the approximate matching of words (e.g., phonetic spelling), and the ability to perform keyword searches on subject headings (e.g., Walker,[1] Walker and Jones,[2] and Lester[3]). The second group, also exemplified by Lester,[4] looks at complete bibliographic records and determines how much retrieval would be improved were all fields equally searchable.

The third group recognizes that subject access might be improved considerably were existing bibliographic records enhanced by the addition of further access points taken, for example, from tables of contents or back-of-the-book indexes. This approach can be traced back some years (e.g., Atherton,[5] Wormell[6]). Recently, Byrne and Micco discovered, not surprisingly, that greatly improved recall could be obtained when MARC records in a database were enhanced by adding to each an average of twenty-one multiword terms drawn from indexes and tables of contents,[7] Using a somewhat different approach, Diodato confirmed that terms used by readers to describe books do tend to match terms occurring in indexes and tables of contents.[8]

The fourth group of studies looks at the effect of making additional searching aids

available to catalog users. Bates proposes two such tools that could be used in existing catalogs based on *Library of Congress Subject Headings* (LCSH) (an end-user thesaurus-basically a vast entry vocabulary-and a semantic network, incorporating the entry terms, that allows a searcher to select from a variety of methods for generating semantic associations), but she does not actually test them,[9] The most obvious searching aid would be a subject authority file, incorporating cross-references. Lester found that such an authority file had relatively little effect on the ability of catalog users to match their subject terms with *LCSH* headings, while Van Pulis and Ludy found that subject authority files are little used even when made available online,[10, 11] Jamieson et al. have compared the value of the authority control approach with the ability to perform keyword searches in complete bibliographic records.[12]

Many keyword searches in large online catalogs would be successful in the sense that they would retrieve relevant items, but they would also retrieve substantial numbers of irrelevant items, and would bring out so many records that the user would be discouraged from proceeding further. The fifth group of studies, exemplified by work now proceeding at the OCLC Online Computer Library Center, looks at ways in which such large retrievals can be successfully limited-by date, language, or other characteristics.

In addition to these studies, many others have looked at the possibility of building some form of user-friendly interface to allow a library user to perform a subject search without understanding search strategy or search logic, perhaps by entering a narrative statement of an information need. This approach is exemplified by the work of Salton and McGill,[13] Doszkoes,[14] Biswas et al.,[15] Clemencin,[10] and Pollitt, [17] among others.

Finally, one can identify studies that seek to apply artificial Intelligence or expert system approaches to the library subject-access problem. For example, Micco et al. describe work designed to produce an expert system capable of searching for and providing access to knowledge at the same level as a skilled reference librarian.[18]

Limitations of Earlier Studies

It is encouraging to see so much activity in this important area, and the studies performed in the last several years have added significantly to our store of knowledge on the behavior of catalog users and the performance of the subject catalog in libraries.

In general, however, almost all of the studies suffer from the fact that they rely on rather crude or simplistic measures of searching success. This is a problem that has always bedeviled catalog-use studies (e.g., Lancaster[19, 20]). It is comparatively easy to evaluate a "known Item" search in a library catalog; either n user finds the item or does not. A subject search cannot be evaluated on such a simple binary scale. Instead, one needs a measure of *the degree of success* of a search.

While excellent catalog-use studies have been performed in the past (e.g., Lipetz,[21] and Tagliacozzo and Kochen[22]), such studies have been weak in methodologies used for the evaluation of subject searches. The simplest approach (and the one still most commonly used—see Lester[23]) is to judge a search successful if the user is able to match subject terminology with the terminology of the catalog (examples of this approach can be found in the work of Bates [24,25]). Clearly, this is a crude measure of success, since it gives no indication of whether or not a user would find *anything useful* in this way, much less whether the most relevant items would be located.

In a somewhat more sophisticated approach, a subject search is judged successful if the catalog user selects one or more items (and presumably borrows them) as the result of a search.

This is an improvement, certainly, but the evaluation criterion is still very unsatisfactory.

The quality of subject access in library catalogs cannot be improved from the results of studies based on such imperfect criteria. A subject search in the catalog of a library cannot be considered fully successful unless the user is able to locate the material that is, in some sense, the "best," i.e., the most complete, the most up-to-date, or the most authoritative. No previous studies of subject searching in library catalogs have used such a stringent criterion.

The study reported here used a series of simulations to determine the probability that a skilled catalog user would retrieve "the best" materials available in a library on some subject and, if they are unable to retrieve the best materials, to determine what changes would be needed to ensure that future catalogs would allow more successful subject searching (i.e,,searching that produces more of the better materials). [25]

Methods

Fifty-one bibliographies representing recommended readings on a wide range of topics were assembled. The original intention was that most of these would be obtained from faculty members of the University of Illinois and neighboring institutions. Surprisingly, this proved to be much more difficult than expected: even professors who are acknowledged experts in a field show great reluctance when asked to produce a list of "best" readings in their areas of specialization, While a few such lists were obtained, a much more productive source was the recommended readings appearing in recently published articles in encyclopedias or encyclopedic dictionaries. The use of these can be justified on the grounds that the authors of such articles are subject experts and the bibliographic items they refer to were presumably chosen because they are considered to make an important contribution to some aspect of the subject discussed. The encyclopedias from which bibliographies were drawn are all specialized in scope and recently published (none before 1983 and many published in 1987-89). In a few cases only, alternative sources were used, the bibliographies being taken from handbooks, textbooks, or journal articles. The topics used in this study, and the sources from which the bibliographies were drawn, are given In table 1.

The sample of topics used in the study, then, was more "opportunistic" than anything else. That is, topics were determined by the availability of fairly recent, expert-prepared, specialized bibliographies containing significant numbers of items likely to appear in the catalog of a research library. As it happens, more topics fall in the social sciences than fall in the sciences or humanities.

For each bibliography thus obtained, the following steps were taken:

1. Journal articles were eliminated, since traditionally these have not appeared in library catalogs (a situation that is now beginning to change).
2. A search on the topic was performed in the "full" online catalog of the University of Illinois, the Full Bibliographic Record (FBR). The FBR contains about 4.5 million bibliographic records. These can be searched by author, title, keywords in title, subject headings and subheadings, and other access points. A limited Boolean searching capability exists in the catalog. The searches were performed by two members of the research team who had studied the capabilities of the FBR and had become highly proficient in searching this tool. They performed each search on the basis of the title of the encyclopedia article (or other source) only and did not see the bibliography until after the search was completed.

Table 1

Topics Used as Basis For the 51 Searches

Search Number	Topic	Source
1	Censorship in the Soviet Union	Faculty member
2	Pre-Columbian religions and iconography	*Encyclopedia of Religion* (1987)
3	Spirit possession	*Encyclopedia of Religion* (1987)
4	Growth of the literature of science	Faculty member
5	Critical theory	*International Encyclopedia of Education* (1989)
6	Transport properties of electrolyte solutions	*Encyclopedia of Physical Science and Technology* (1987)
7	International banking	*Encyclopedia Americana* (1988)
8	Education of the deaf and hearing impaired	*International Encyclopedia of Education* (1989)
9	The image of women in the Bible	Faculty member
10	Hunger and malnutrition in the U.S.	*Encyclopedia of Social Work* (1987)
11	Migrant and seasonal farm workers	*Encyclopedia of Social Work* (1987)
12	Corporate social responsibility	*Encyclopedia of Social Work* (1987)
13	Runaway children and adolescents	*Encyclopedia of Social Work* (1987)
14	Learning and instruction for teachers	Faculty member
15	Noise hazards to humans	*Oxford Textbook of Public Health* (1985)
16	Military tradition in the southern United States	*Encyclopedia of Southern Culture* (1989)
17	Agriculture and agribusiness in the southern United States	*Encyclopedia of Southern Culture* (1989)
18	Feminist methodology in scholarly inquiry	*Hypatia*, 2, 3, 1987
19	Humor in child development	*International Encyclopedia of Education* (1989)
20	The politics of education	*International Encyclopedia of Education* (1989)
21	Queuing theory	*Encyclopedia of Physical Science and Technology* (1987)
22	Group teaching in higher education	*International Encyclopedia of Education* (1989)
23	Sociology of science	Faculty member
24	Economic progress of blacks in the USA	*Journal of Economic Literature* (1989)
25	Latifundio	*New Palgrave Dictionary of Economics* (1987)
26	Blues progression	*New Grove Dictionary of Jazz* (1988)

Table 1 Continued

Search Number	Topic	Source
27	Creationism	Faculty member
28	Political music	*New Grove Dictionary of American Music* (1986)
29	Theory of games	*The New Palgrave Dictionary of Economics* (1987)
30	Male midlife transition	*Men's Studies*, by E. R. August (1985)
31	Gumbel distribution	*Encyclopedia of Statistical Sciences* (1983)
32	Photosynthesis in biotechnology	*Biotechnology* (ed. by Rehm and Reed) (1988)
33	Crazing of polymers	*Encyclopedia of Polymer Science and Engineering* (1986)
34	Oracles	*Encyclopedia of Religion* (Macmillan, 1987)
35	Celtic religion	*Encyclopedia of Religion* (Macmillan, 1987)
36	Tarot	*Encyclopedia of Occultism and Parapsychology* (1985)
37	Paperbacks	Faculty member
38	Publishing as a business	Faculty member
39	Jainism	*Religions of India* (Clarion Books, 1983)
40	Stability theory	*Systems and Control Encyclopedia* (1987)
41	Hazards from lead	*Systems and Control Encyclopedia* (1987)
42	Arabic theater	*McGraw-Hill Encyclopedia of World Drama* (1984)
43	Using magnetic methods in testing of materials	*Encyclopedia of Materials Science and Engineering* (1986)
44	Olfactory psychophysics	*Encyclopedia of Neuroscience* (1987)
45	Urbanization of birds	*A Dictionary of Birds* (1985)
46	Classification of birds	*A Dictionary of Birds* (1985)
47	Huntington's Chorea	*Handbook of Neurochemistry* (Second edition. Plenum Press, 1985)
48	The peasant commune in Russia	*Blackwell Encyclopedia of the Russian Revolution* (1988)
49	Anarchism in Russia	*Blackwell Encyclopedia of the Russian Revolution* (1988)
50	Pacificism in Japan	*Kodansha Encyclopedia of Japan* (1983)
51	Printing in Japan	*Kodansha Encyclopedia of Japan* (1983)

3. For items in the bibliography not retrieved by this subject search, author/title searches were performed in the FBR and the full bibliographic records for these items were printed out. At this point, items not appearing in the FBR, and presumably not owned by the University of Illinois, were eliminated from further consideration.
4. An analysis was performed to determine why Items presumed to be relevant to a particular topic, and judged sufficiently important to be cited by the author of an article on this topic or listed by a faculty member, were not retrieved in the original subject search, and how the search strategy or characteristics of the catalog would have to be changed to allow these to be retrieved. Some items could have been retrieved by the use of alternative subject headings that were in some way related to tine headings used by the searcher. Others could hove been retrieved by expanding the search to other elements in the existing bibliographic record, such as title words. However, many could only be retrieved by the expansion of the existing records to include the contents pages of books and/or their indexes, and some could only be retrieved if the full text of the book were available to be searched. In many cases, then, the book itself had to be retrieved to allow these determinations to be made. In this step of the analysis, it was found that some of the items appearing in the bibliographies were not fully relevant to the subject of the encyclopedia article and, thus, to the subject search. When members of the team agreed on this, such items were eliminated from the search. In many cases the item thus rejected covered only one facet of a multifaceted topic, For example, the author of an article on education of the handicapped might cite a book that deals with education but not the handicapped or one that deals with the handicapped but not with education; in situations of this kind, the item was omitted from the study. In some other cases, the item in the bibliography had been cited by the author (e.g., for methodological reasons) but fell clearly outside the subject domain of the article.

It is important to emphasize two facts about the investigation: it was not our intention to evaluate the FBR per se or to evaluate the performance of particular searchers. The objective was to determine what characteristics an online catalog would need to have in order to permit the retrieval of the "most important" literature on some topic as defined earlier. The entire study could hove been performed without the conduct of any subject searches. That is, author/title searches could have been performed for all Items in the bibliography, and the analysis could have been achieved by looking at the full bibliographic records and the books themselves. The disadvantage of this, of course, is that a decision would have to be made on each subject heading involved as to whether an experienced searcher would be likely to use it. The use of an actual searcher in the first step of the process avoided this dilemma and provided a more realistic approach,

Results

The results of the fifty-one searches are summarized in table 2. In the first search, for example, sixty-six of the items in the bibliography were confirmed to appear in FBR, but only fifteen of those wore retrieved in the subject search, giving a recall ratio of 22.7%. As the table shows, the results varied from eight cases having 100% recall to two searches with zero recall. The mean recall ratio for the fifty-one searches-the average of all the individual ratios-is 59.4%.

Table 2

Recall Achieved in 51 Searches

Search	Recall No.	Recall %
1	15/66	22.7
2	6/12	50.0
3	12/23	52.2
4	0/6	0
5	2/13	15.4
6	4/7	57.1
7	3/5	60.0
8	4/17	23.5
9	6/8	75.0
10	5/7	71.4
11	0/1	0
12	4/8	50.0
13	11/19	57.9
14	2/5	40.0
15	3/4	75.0
16	3/9	33.3
17	3/6	50.0
18	11/12	91.7
19	2/9	22.2
20	22/47	46.8
21	10/10	100.0
22	6/21	28.6
23	13/22	59.1
24	6/15	40.0
25	8/13	61.5
26	5/5	100.0
27	10/10	100.0
28	4/13	30.8
29	21/36	58.3
30	14/15	93.3
31	12/15	80.0
32	6/11	54.5
33	2/4	50.0
34	11/23	47.8
35	5/10	50.0
36	8/9	88.9
37	4/4	100.0

Table 2 Continued

Search	Recall No.	Recall %
38	13/13	100.0
39	3/7	42.9
40	12/17	70.6
41	5/7	71.4
42	6/6	100.0
43	4/6	66.7
44	2/3	66.7
45	1/1	100.0
46	4/5	80.0
47	2/5	40.0
48	7/7	100.0
49	2/5	40.0
50	1/2	50.0
51	2/3	66.7

On the surface, 59% recall could be considered a respectable, if not exactly inspiring, result. However, this is very misleading, for several obvious reasons:

1. The searchers were students of library science who had acquired considerable experience in searching the catalog. The results they achieved would not be duplicated by a typical library user.
2. They studied *LCSH* with some degree of intensity before beginning a search, a situation not likely to be true for the typical catalog user.
3. They were instructed to perform broad searches, to achieve maximum recall, *with no concern given to the precision of the search,*[27] For example, search 18, on feminist methodology In scholarly inquiry, achieved a recall of more than 90%, but only through the use of the term *Feminism,* which retrieves bibliographic records for close to 1,200 items, almost all of which are completely irrelevant to the precise topic of the search. If the search had been restricted to more specific terms, such as *Women in science* or *Women scientists,* recall would have been much lower-only about 42%. To get a high recall on the Gumbel distribution (search number 31), which relates to the statistics of extremes, requires use of such broad terms as *Mathematical statistics* and *Stochastic processes,* which retrieve records for more than 1,200 Items. The same situation applies to other searches. While recall was high in a few of the fifty-one searches, these results would not be achieved under real-life conditions because a library user would just not be willing to look through hundreds of records to find a handful of relevant items.

   The results are misleading in one other respect: a significant number of the items in the bibliographies are journal articles, which have not traditionally been included in library catalogs; thus, the results really represent only 59% recall of part of the literature.

   There are relatively few searches in which a high recall could be achieved at an acceptable level

of precision, This tends to occur only in situations where the subject of the search coincides closely with a subject heading or headings. For example, search number *9*, on the image of women in the Bible, achieved 75% recall on the single term *Women in the Bible* and could have achieved 100% recall by use of the additional term *Women (theology),* and search number 21, on queuing theory, achieved 80% recall on *Queuing theory* alone. Such a close match between a subject heading and the topic of a search was rare and may well be rare in real life.

The main purpose of the present study was to determine what might be done to library catalogs to make them more effective tools for subject access. Table 3 sheds light on this by showing how the items in the present study could have been retrieved. The fifty-one bibliographies collectively contained 607 items included within FBR, and of these, 327 were retrieved in the subject searches. If we simply average these numbers (327/607) we get an average recall of 53.9%-a slightly different figure from the *50%* achieved by averaging the individual ratios,

Table 3

How Results Could Be Improved for the 51 Searches

Total number of relevant items in FBR for 51 searches	607	
Number of relevant items retrieved in 51 searches	327	
Recall ratio (327/607)	53.9%	
Possible Improvement	Additional Items Retrievable	Revised Recall (%)
Elements in existing bibliographic record		
Other closely related subject headings	36	60.1
Closely related and somewhat related headings	51	62.3
Other parts of record	10	55.5
Subtotal	61	63.9
Enhancements to record		
Indexes of books	125	74.5
Contents pages	80	68.0
Full text	58	63.4
Subtotal	211*	90.3
Not retrievable even on full text	8	

The categories "indexes of boots" and "contents pages" are not mutually exclusive.

Table 3 shows clearly that the best "hindsight" approach to searching the existing bibliographic records could only improve the average recall from 53.9% to 63.9%. If the searchers had used all subject headings that could be considered closely related to the subjects they were dealing with, recall would only have improved about six percentage points, from 53.9% to 60.1%, The addition of subject headings considered "somewhat related" would push recall only to 62.3%. Of course, the decision that a heading is "closely related" or "somewhat related" to a topic is a subjective one, but the decisions reflected some degree of agreement among members of the project team. In general, these decisions were generous to the existing bibliographic records in that we considered as "related" headings that were only loosely connected to the search topic. For example, *Glossolalia* was accepted as closely related to "spirit possession" *(LCSH* does link them) and *Poverty-Government policy-United States* as closely related to "hunger and malnutrition in the U.S.," while *Revelation* and *Prophets* were considered somewhat related to "oracles" *(LCSH* does

not link them) and *Numerical taxonomy* (a very broad term) as somewhat related to "the classification of birds."

If the searches had been broadened to include other parts of the existing bibliographic records, beyond the subject headings, little improvement in recall would have occurred. Only 10 of the 229 items not retrievable on subject headings could have been retrieved on other parts of the bibliographic record, in this case titles or subtitles. That extending a search from subject headings to titles or subtitles has minimal effect on recall suggests that the subject headings assigned are very "close" to the terminology of titles and that there is little complementarity between titles and subject headings.[28]

As table 3 shows, the average recall for the fifty-one searches could not have exceeded 63.9% even if the searchers had used all subject headings of any degree of relevance to the sought topics and had extended the search to keywords in titles. Had they done this, of course, precision would have been even worse than it was with the approaches actually used.

Unfortunately, there is very little that can be done to improve the situation on the basis of existing bibliographic records and cataloging practice. Searches performed in databases that are the electronic equivalents of printed indexes can achieve better results *(i.e.,* a reasonable level of recall at a tolerable level of precision) through flexible capabilities for Boolean search, but even the most sophisticated of capabilities would have had little effect on the results of the present study. The reason, of course, is that a typical catalog record has too few access points to make it likely that a search combining terms will get an acceptable level of recall: a record having two or three subject headings Is quite different from one including ten or twelve descriptors and a 200-word abstract This is illustrated clearly in search number 32, dealing with photosynthesis in biotechnology. *Photosynthesis* and *Biotechnology* are both *LCSH* headings, but not one of the records for the eleven relevant items contains both headings. In fact, in four of the six records for relevant items having the heading *Photosynthesis,* this is the *only* term assigned. It seems likely that most real information needs are multifaceted; censorship in the Soviet Union (not all of censorship or everything on the Soviet Union), crazing of polymers (not everything on polymers), humor in child development (not all of humor), and so on. Such multifaceted topics can be handled in library catalogs as long as they coincide with existing subject headings or subject heading-subheading combinations (e.g., *Censorship-Soviet Union* and *Humor in children)* but there is little hope that in other cases two or more facets of a search topic will be represented in existing catalog records (by combinations of subject headings, keywords, or both).

This study was not intended as an evaluation of a particular online catalog, and FBB has many limitations that make it far from an ideal tool for subject searching. Nevertheless, with existing bibliographic records, even the most powerful of searching capabilities would offer only marginal improvement. Some improvement could be achieved in a catalog that imposed much greater structure on the subject headings used, allowing a searcher to bring in a whole category of related headings and subheadings in much the same way that a user of MEDLINE can "explode" on a term hierarchy. For example, search number 2 deals with pre-Columbian religions. To get a high recall here would require that the searcher be able to recognize and enter an extensive list of names of Indian groups or civilizations (with the subheading *religion and mythology)* as well as the names of the countries of Central America with appropriate subheadings *(religion and mythology, rites and ceremonies,* and perhaps even *(antiquities).*Searches of this kind could be aided by the compilation and storage of "trees" or "hedges" (e.g., on Central America, on Indians) that can be called up and used intact by the searcher.

A similar example occurred in the search (number 23) on the sociology of science. The

heading *Science-social aspects* will retrieve some of this literature, but a more comprehensive search would require the use of the subheadings *social aspects* or *sociological aspects* with a very wide range of science-related terms (e.g., *Physics, Laboratories,* or *Biological laboratories).* Searches of this kind would be much easier if the system stored a science "hedge" (I.e., a table of science-related terms) to which a searcher could append selected subheadings, but such a feature would be an aid for the sophisticated scorcher rather than the typical library user.

There are other ways in which subject searching in conventional library catalogs could be improved (including more cross-referencing among subject headings and between subject headings and related names-e.g., between *Critical theory* and Freire and Habermas) but they could have only a very marginal effect. The results of this study strongly suggest that a sophisticated and experienced searcher in an online catalog is unlikely to retrieve, on the average, more than 50-60% of the items appearing in subject bibliographies prepared by experts, and that this level of recall could only be achieved at quite intolerable levels of precision. The results achieved by a less experienced searcher would be much worse. Moreover, there is no way that the situation can be improved significantly (e.g., by mapping of user vocabulary to subject headings or parts of subject headings in various ways) within the constraints of existing catalog records.

There are still those who cling to the belief that the use of classification schemes can lead to significant improvements in subject access in online catalogs (e.g., Drabenstott et al.[29]). This was not investigated systematically in the present research because it was recognized that the scatter of related material would be too great to make this approach worth study. That this assumption was correct is borne out by the fact that the sixty-six items considered relevant to censorship in the Soviet Union were scattered over forty-one numbers in the *Dewey Decimal Classification*.

In summary, some records known to be present in the catalog were not retrieved by subject because the searcher did not exhaust all subject heading possibilities and because the particular catalog used offers little in the way of searching aids. However, these factors had a very minor effect on the results. Overwhelmingly, the subject search failures in this study were caused by the fact that the subject matter of items included in library catalogs is represented in a completely inadequate way in the traditional bibliographic record.

The lower part of table 3 illustrates what is possible through various forms of enhancement of the catalog records. In the analysis, preference was always given to retrieval through the existing bibliographic records. That is, if the record for an item could be retrieved on a further subject heading or title keyword, no attempt was made to determine whether it was also retrievable through the terms found in its Index, contents pages, or full text. Thus, as an example, records for the 125 items retrievable through the terms in back-of-the-book indexes could *not* have been retrieved using any part of the existing bibliographic records.

The data that relate to the enhanced records are not cumulative with the data from existing records. For example, searches on terms from the book indexes would retrieve records for 125 Items more than the 327 actually retrieved (i.e., would raise recall from 53.9% to 74.5%) and 125 more than the 388 (327 + 61) potentially retrievable through the existing records. In other words, existing records plus book Indexes could raise recall to 513/607, or 84.5%.

Note that the results for indexes and contents pages are not mutually exclusive: records for some items could be retrieved using terms from either component. Recall is potentially greater for the indexes than for the contents pages, even though more books have contents pages than have indexes, because indexes tend to offer many more access points than contents pages do.

Table 3 shows that records for some 58 of the 607 items could only be retrieved on words occurring in the full text of the book and eight are not even retrievable on full text. These items are

relevant "by analogy," but the words needed to retrieve them *do not appear in the text.*

The results shown in table 3 might suggest that the problems of subject access in library catalogs could largely be solved were the text of contents pages and/or indexes stored in a form suitable for searching. Nothing could be further from the truth. Even if this were economically feasible, it would make little practical difference to the retrieval capabilities of a large catalog because the resulting precision would be completely intolerable. It is almost impossible to calculate how frequently a particular term or term combination might occur in indexes or contents pages for a collection of several million items, but it is safe to say that many searches on such extended records would retrieve thousands of items rather than the hundreds that were retrieved In many of the searches on existing records alone. Only in the case of an atypically specific search, involving a rather rare word or name (such as Gumbel), might the enhanced record improve search results. In other cases, any improvement in recall would be accompanied by a disastrous decline in precision.

Moreover, records for some Items could be retrieved using terms from index or contents pages only through some ingenuity on the part of the searcher. For example, Rescher's book *Scientific Progress,* highly relevant to growth of the literature of science, refers (contents page) to growth of the "scientific enterprise" and to growth in "scientific progress," but makes no explicit reference to the literature of science.

Of course, one could reach a different conclusion from the results of this study: that the solution to the problem lies in the adoption of a detailed level of analytical subject cataloging, with twenty or thirty subject headings per item rather than the two or three more typical of present practice. This would be enormously expensive. Moreover, it would have less effect than table 3 might suggest, since these results are arrived at by hindsight. For example, the memoirs of Shostakovich We some relevance to censorship in the Soviet Union, as well as to many other specific topics. But there is no guarantee that a cataloger or indexer would recognize the relevance of this work to all of these topics even if he or she were allowed to assign an unlimited number of subject headings. Twenty different scholars might all find in this work certain portions that have some relevance to their areas of specialization, but it is by no means certain that relationships of this kind would be recognized by any but the subject specialist. Of course, this is not to imply that indexers or cataloged should be able to recognize every possible context to which a publication may apply but, rather, that subject experts can see relationships that others would fail to see.

Implications

Certain assumptions underlie this study. The major one is that the readings on some topic suggested by a subject expert are in fact important items that one would want to retrieve in a search on this topic in a library catalog, In the case of faculty reading lists, this seems self-evident. The situation is less clear for the bibliographies associated with encyclopedia articles. Nevertheless, it seems reasonable to assume that the items listed by the authors of such articles, if they are directly relevant to the topic discussed, are considered to be important contributions to the literature on this topic.

The second assumption is that a library user would want to retrieve these important items in preference to others that might exist in the catalog. In this study, comprehensive searches were performed, not because the typical library user will want such a comprehensive search (most will not), but to determine to what extent the items considered important by the expert could be retrieved by the persistent and diligent searcher.

The fact is that library catalogs permit only the most superficial of subject searches. In the first place, they rarely include periodical articles, which are the most important sources of information for many topics. Further, they tend to provide access only at the level of the complete bibliographic item rather than at die level of the subitem (a particular chapter, article, conference paper, or paragraph), A book that deals substantially with topic X is not necessarily a more important contribution to that topic than an article in a Journal, encyclopedia, or handbook; a conference papers or a chapter in another book. The catalog fails the searcher by providing access to only a small part of the literature that exists in the library on a particular topic. Moreover, the literature for which it does provide some level of subject access is not necessarily the best available in the library on any particular topic, The library catalog, as it now exists, may provide adequate subject access for a small collection-for example, in a school or small public library-or to lead to a few items, not necessarily the best, on some topic, but it is quite inadequate for a large, multidisciplinary library, especially one that attempts to support educational or scholarly needs.

Despite popular belief, the transformation of the card catalog into an online database has not significantly improved subject access. Indeed, it may have made the situation worse because it has led to the creation of much larger catalogs that represent the holdings of many libraries. Merging several catalogs into one, when each component catalog provides inadequate subject access, exacerbates the problem, since the larger the catalog the more discriminating must be the subject access points provided. But catalogs have grown much larger without any significant compensatory increase in their discriminating power. The application of the most sophisticated of searching software to any large catalog of the type traditionally used in libraries would make little difference to its performance: the records stored are completely inadequate representations of the subject matter with which they deal. In a database providing subject access to periodical articles, such as MEDLINE, a five-page item might be represented by ten or twelve subject headings, as well as keywords in titles and abstracts. In contrast, a 400-page book on the same subject might only be accessible in the catalog of an academic library by two subject headings, the title words, and perhaps a classification number.

This investigation was begun in the hope of identifying practical ways in which online catalogs could be made more effective tools for subject searching. However, the results suggest that significant improvements are not possible within the constraints of existing subject cataloging practice, The conclusion that emerges most clearly is that, if one wants to know the best things to read on some topic, there is no substitute for consulting an expert, either directly or indirectly (e.g., through an expert-compiled bibliography),

This conclusion should not come as much of a surprise, investigations over many years have consistently shown that seekers of information find much of what they use from specialized bibliographies or bibliographic references in items already known, rather than from databases, library catalogs, or consulting librarians. Moreover, more recent studies (e.g., Knightly,[30] and Bayer and Jahoda[31]) have shown that use of online services seems not to have much influence in changing these traditional searching methods. The formal subject access tools are not effective in locating all of the literature on some subject and might not locate much of the literature that subject specialists consider most valuable. One example of this can be found in a study by Davison,[32] which reports on the results of searching techniques used to compile a comprehensive database on costs and modeling in information retrieval. The 6,098 items judged relevant were drawn from forty different sources. Printed bibliographies were found to be the most productive sources, and the online search of databases gave the worst results (only 5% of the relevant references retrieved).

At the beginning of this article it was pointed out that much research has been performed,

and continues to be performed, on ways to improve subject access in online catalogs. The results of the present study suggest that the methods investigated, or advocated, that are intended to improve access to existing records (including truncation and word-fragment searching, whether applied to titles or subject headings, and other methods of matching user terms to terms in records, as well as all types of searching aids-expanded thesauri, semantic networks, entry vocabularies, or whatever) could have only a marginal effect on subject access, while methods that call for greatly enhanced records (indexes, contents pages, or both) are completely impractical, at least for catalogs of any significant size.

It is ironic that the computer and telecommunications technologies that have greatly improved the document-delivery capabilities of libraries might actually have caused a deterioration in subject access. The library profession should accept the fact that catalogs providing access to multi-million-volume resources can never be more than very crude tools when applied to subject searching. For a finer level of access, or more comprehensive capabilities, it would do well to look for alternative solutions.

One possibility would be the development of an alternative online subject access tool, encyclopedic in scope, that contains recommended readings on a wide variety of topics. The recommended readings could be given at, say, three levels: an elementary level, listing a few periodical articles, chapters, complete books, or whatever, recommended for the beginner;
an intermediate level; and a more comprehensive level-in essence a detailed specialized bibliography. The items in such a database could be likened to the "pathfinders" that were so popular in libraries some years ago.[33]

The database, then, could be considered a database of subject "modules." It would be much more comprehensive than the sum of the specialized bibliographies now in existence in printed form and would compensate for the fact that these bibliographies are widely scattered and thus difficult to locate. It could be linked to the holdings of individual libraries, or groups of libraries, preferably by such unique identifiers as the International Standard Book Number (ISBN) or an international standard number for journal articles. That is, the seeker of information would first consult this tool and then switch to another database to identify those items that are available locally.

The database proposed could be conceptualized as an encyclopedia having topical headings and reading lists, but no text beyond that required to explicate the scope of the entry, but a better analogy might be to consider it an amalgamation of subject bibliographies, general and special.

From what sources could such a database be compiled? Using the reading lists associated with recent encyclopedia articles, as was done in the present study, might be a good starting point, perhaps supplemented by the bibliographies in recent review articles. In the longer term, however, the compiling and updating of such a tool could be a cooperative venture within the library profession, with special libraries and information centers accepting the responsibility for building and maintaining modules corresponding to their areas of expertise.

Access to the database could be through the topical headings, supplemented perhaps by additional access points (assigned subject terms or keywords in scope notes) and less-conventional approaches-e.g., entry of a bibliographic reference by a user (representing an item already known to be highly relevant) could lead to the module or modules in which this reference appears. Modules could be linked through cross-references, and each module could be made a gateway to further sources of information-for example, by pointing to other databases.

The development of a multidisciplinary, encyclopedic bibliographic tool of this type would

require the commitment of considerable resources, but these resources would be much better spent on this endeavor than on attempts to improve existing roots.[34]

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26. It is possible that not everyone will be willing to accept that catalog users seek the "best" materials, Nevertheless,

it is the contention of the authors that even the reader seeking a single book by way of introduction to some topic would prefer one recommended by an expert in the field rather than one not so recommended.

27. It is important to note that "broad search" here means use of all seemingly relevant terms, at any level of specificity, and not just use of the broadest applicable subject headings. Thus, a search on Pre-Columbian religions would include terms related to specific religions as well as the more general terms,
28. However, this does not tell the full story. In the present investigation a significant number of the items sought were relevant in part (e.g., a single chapter in a book) and neither subject headings nor title words offer useful access points to the part. This is why the results differ from those of earlier investigators (see, for example, Ann H. Schabas, "Postcoordinate Retrieval: A Comparison of Two Indexing Languages," *Journal of the American Society for Information Science* 33:32-37 (1982)) who found that title words do make a significant difference (n the subject searching of library catalogs.
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33. The idea that some form of subject bibliography should substitute for subject access through the catalog of an academic library is far from new (see, for example,
    Elmer Michael Schloeder, "Selective Subject Cataloging: A Preliminary Analysts of a Possible Mentis of Deducing the Bulk of the Catalog in the University Library" [M.A. diss., University of Chicago, Graduate Library School, 1945], and Wesley Simonton, "Duplication of Subject Entries In the Catalog of a University Library and Bibliographies in English Literature," *College* 6 *Research Libraries* 11:215-21 [1950]), However, online technology now gives us the ability to make a comprehensive database of specialized subject bibliographies available to all libraries,
34. It is interesting to note some similarities between what is proposed here and a recent suggestion made by Michael E. D. Koenig ("Linking Library Users: A Culture Change in Librarianship," American *Libraries* 21:844-49 [1900]), Koenig points out that "Library patrons want authoritative Information" and advocates a procedure whereby library users can add their evaluations of what they have read to online library catalogs.